

Disease Prevention: The Challenge of the Future

Sixth Annual Matthew B. Rosenhaus Lecture

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I am deeply grateful for this extraordinary honor and opportunity you have given me. I am keenly aware of the contribution of the American Public Health Association to progress in disease prevention. This occasion has provided a powerful stimulus for me to examine the challenge of prevention, to try to go a step beyond my previous thinking on this crucial subject.

When I came to the Institute of Medicine in the fall of 1975, I promptly decided that one of our highest priorities should be in this area. As soon as possible, we established a Division of Disease Prevention and Health Promotion, with Dr. Elena Nightingale as staff director and Dr. Lester Breslow as Chairman of the IOM Advisory Committee on this subject. Since then, this has consistently been one of our most vital and productive divisions.¹⁻⁶ I certainly hope we are making a useful impact on health policy in this area. One of the first activities was a reassessment of poliomyelitis immunization with Dr. Bernard Greenberg as Chairman.⁷ In a curious way, prevention has recently been rediscovered.⁸ Its importance in the future is likely to be rising steadily. Why has it been necessary to rediscover disease prevention when the profound value of this approach was well demonstrated in the nineteenth and early twentieth centuries? No doubt many factors contributed to the decline in appreciation, and I will not try to analyze it in depth. But let me say a little about this decline as background for our current challenge.

The unprecedented advances in life sciences in the past quarter century, with powerful implications for understanding of disease, encouraged us to believe that before long we would have "magic bullets" for whatever ails us. Our own all-too-human wishful thinking, dramatized as never before by mass media of unprecedented reach and impact, reinforced this expectation. Why worry about preventing disease when we will soon be able to cure it? Why not live our lives however we enjoy, fascinated with the new opportunities opened up for us first by dependable agriculture,

then by the industrial revolution, and now, in a moment of evolutionary time, by the high technology society? Should we not feel free to damage our bodies however we wish, secure in the knowledge that high technology medicine will be able to pick up the pieces and put them back together? Moreover, individual curative medicine provides for the patient eternal hope; and for the provider the satisfaction of grateful patients, intellectual challenge, community respect and excellent income.

These elements and more provide a potent reward system for total commitment to curative, individual medicine—and few incentives for the rather abstract and impersonal work of analyzing the many factors determining the health of the population, and taking steps to prevent disease in behalf of large numbers of nameless, faceless people.

Given this seductive view of curative, individual medicine, and the authentic achievements of this approach, how does it happen that disease prevention has been rediscovered at all? First let me caution that the rediscovery is as yet incomplete. The commitment, priority, and funding do not yet match the rhetoric. However, the voice of reason is small but persistent. The facts of disease prevention are mostly undramatic, but growing rapidly in significance.

We have awakened in 1978 to find that disease is yet with us, large and small; that death is not abolished even with a considerable array of "magic bullets" at our disposal—and even with the Institute of Medicine hard at work on national health policy! Indeed the burden of illness is still heavy, though quite different than it was in the early part of this century. A growing body of facts about our burden of illness is helping to open our eyes and our minds to new perspectives—and to the reformation of useful old perspectives. We will need a balance between curative and preventive measures.

Burden of Illness

What is the burden of illness in developed and developing countries? Going beyond mortality rates, Rice, White and Feldman document the total burden of illness in the United States on such dimensions as: 1) potential years of

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life lost (compared with an appropriate population measure of life expectancy); 2) inpatient days; 3) work-lost days; 4) limitations of major activities; and 5) economic costs.⁹

The burden of early death and long-term disability in most developing countries of the world today is exceedingly heavy. Severe and common tropical diseases, and a much wider range of infectious diseases, are embedded in the context of widespread malnutrition and population numbers that exceed the support capacity of most developing countries. Susceptibility to a wide range of diseases is heightened by the marginal character of subsistence. This raises ethical questions for countries with strong scientific capability. In recent years, we Americans have given little attention—in research, education and practice—to some of the most important disease problems in the developing countries. This situation is beginning to change for the better, and we in the Institute of Medicine are doing everything in our power to aid in this effort.¹⁰⁻¹³

In respect to the burden of illness in industrialized nations, our neighbors in Canada have heightened awareness of the main problems. In the landmark report, "A New Perspective on the Health of Canadians," principal causes of death were measured in terms of years of life lost as calculated against the average life expectancy of age 70.¹⁴ In Canada, motor vehicle accidents account for about 13 per cent of years of life lost; cardiovascular diseases account for about 12 per cent; all other accidents, apart from motor vehicles, account for about 11 per cent of years of life lost; respiratory diseases, particularly lung cancer, account for 8 per cent; and suicide about 4 per cent.

The profile of illness, disability, and death in the United States has changed substantially in recent decades in directions similar to those of Canada. Note that the behavioral and environmental components of these problems in Canada, the USA and other industrialized countries are very significant: e.g., the risk of smoking for cardiovascular diseases and cancer, the many damaging effects of heavy alcohol use, of risky driving for accidents, and of environmental substances for cancer and other toxicity. There is still reason for concern that some population groups—particularly the poor and socially depreciated—do not benefit adequately from biomedical advances, e.g., the preventive potential of early prenatal and perinatal care. Lest we forget, the greatest threat to health in the future is not cancer, not cardiovascular disease, or even malaria, but violence—accidents, suicide, homicide, terrorism, and war.

What lines of advance can reduce the burden of illness?

- Advances in established biomedical science and technology;
- Broadening the spectrum of health research;
- Innovations in health services with respect to content and organization, e.g., HMOs;
- Changes in education, with respect to preparation for the health professions and education of the general public; and
- Improvement in the data and processes of policy formulation in health.

Let me now briefly evoke a few images of the future—of directions in which we may reasonably expect to find ways

of diminishing the burden of illness—the first in developing countries and then in our own country. But let us remember that we have a developing sector within our own country—poor, malnourished, underserved and subject to many problems similar to those of the less developed countries.

Public health measures in developing countries could ease the burden of illness enormously. There are about a billion people who cannot safely drink or wash with water. Hundreds of millions lack any sanitation facilities. Although simple in principle, the appropriate responses differ according to local and regional circumstances. One kind of sanitary reform is exemplified by the use of hand pumps in Pakistan. These simple instruments do much to prevent disease by drawing needed water from beneath the surface instead of the disease-laden water which is available on top. Sometimes, ingrained traditional patterns of behavior must change before such progress can be made. Combinations of public health, engineering, and behavioral science will be needed to deal with such problems of sanitation and environmental alteration.

The science base of the biological revolution can be applied to disease problems of developing countries. A hopeful sign is that the World Health Organization has established collaborating networks of laboratories around the world to address such massive health problems of the developing countries as human reproduction and tropical diseases.

The whole field of vaccine development and use is of special promise in the next decade. The rediscovery of public health has been fostered in recent years by the virtual eradication of smallpox throughout the world. Yet vaccines are not being utilized to their full potential either in this country or abroad. In 1974, only about 67 per cent of white children and 45 per cent of non-white children ages 1 to 4 in the U.S. had been vaccinated against polio. The comparable figure in northern European countries is above 90 per cent. Having an effective vaccine is not enough. Using it is another matter. We must learn to overcome the psychosocial and technological obstacles to widespread immunization both at home and in the developing countries.

The prospects for new vaccine development are highly significant. The utilization of modern molecular and cellular biology, especially in the context of immunology, offers great promise in relation to viral, bacterial, and parasitic diseases. Perhaps the most important of these world-wide is the prospect of a malaria vaccine, quite possibly in the next decade. Again, having such a vaccine will not be enough. Health services research will be required to facilitate its effective delivery and equitable distribution.

Population Growth and Health

The adverse effects of exceedingly rapid population growth are not only those affecting health, but also education, economic development, resource depletion, pollution, conflict and violence. Thus, in an increasingly interdependent world, the technically advanced nations cannot afford to overlook these problems which are so burdensome

for most of the less developed countries. This involves biomedical and behavioral sciences, in international collaborative efforts. Some promising lines of inquiry deserve consideration here. The general orientation of the WHO effort in this field is to make possible an array of contraceptive techniques and relate these to cultural preferences with respect to acceptability. Two new approaches are of great interest: 1) work on brain peptides, especially the hypothalamic hormone LHRH and its synthetic analogues may well lead to a wider range of chemical, reversible contraceptives. LHRH controls the reproductive system in both sexes; 2) applications of a prostaglandin in a vaginal suppository in what appears to be an efficient and physiological way. The prostaglandin approach is especially interesting because it draws upon an area of rapid advance in biochemistry and physiology. A practical approach to pregnancy interruption is emerging through prostaglandin use in the three weeks following a missed menstrual period. In this interval, the interruption is practically always complete. Current research may lead to a simple, effective technique for self administration.

Even given this future promise, however, we will need a deeper understanding of the reasons why present contraceptive technology has been taken up so slowly in many parts of the world. It has become increasingly clear that the dissemination of contraceptives often comes into conflict with deep-seated traditions and cultural norms. Such beliefs, taught early in life and invested with strong emotions, are hard to change. Increasingly aware of these problems, the World Health Organization is now doing research on the cultural acceptability of contraceptive techniques.¹⁵ Very recently, several major developing countries have made progress in family planning and fertility regulation. A deeper understanding of psychosocial factors influencing population growth can accelerate such progress.¹⁶

Cardiovascular Disease

Let us now consider the principal burdens of cardiovascular disease, arteriosclerosis and hypertension. Increasingly, attention is turning to the detection of cardiovascular risk factors and efforts to diminish them before the disease is dangerously advanced. Cardiovascular epidemiologists have carried out large-scale studies to delineate biological and behavioral characteristics of individuals who are at substantial risk of developing specific cardiovascular diseases. These careful, systematic studies have been conducted with a variety of populations in different parts of the United States as well as in other countries.¹⁷

The cardiovascular risk factors include age, male sex, elevated blood pressure, cigarette smoking, elevated plasma cholesterol, elevated blood glucose, overweight, sedentary way of life, water hardness, family history of heart disease before age 65, personality type, and severe stress. Not all of these have been investigated with equal thoroughness, but all have some predictive power for coronary disease and some have predictive power for stroke as well. Taken together, they can predict at least two out of three untoward

coronary events. Hence, interest in modifying risk factors is high. But this is no easy task. It requires changing firmly established patterns of behavior involving smoking, eating, working, coping with stressful experience and other habits.

As public concern has increased in the past decade, significant changes in risk factors have in fact occurred in the U.S. population. These changes coincide with an accelerating decline in cardiovascular mortality during the past decade.¹⁸ While this may be a coincidence, it deserves further investigation. One point deserves emphasis: not only retrospective but also decisive prospective studies leave little doubt that cessation of cigarette smoking will diminish cardiovascular disease and lung cancer.¹⁹

In regard to hypertension, survey research in the early 1970s showed low public awareness of high blood pressure and its consequences. About one-half of all Americans with high blood pressure were unaware of their condition, and a large proportion of those who were aware were taking no action since they had no impairing symptoms. Only one-eighth of hypertensive persons were being effectively treated. In response to this need, the National High Blood Pressure Education Program was initiated in 1972. Health professionals were informed of the high prevalence of hypertension, its insidious course involving silent progression of tissue damage, its ease of detection, the availability of effective medication, and the opportunities for prevention of serious outcomes. The general public was informed that a great many people have the disease without knowing it, that it can easily be detected and effectively treated, and that long-term persistence in therapy can prevent a stroke, heart failure, and kidney failure. Voluntary health organizations, health professional organizations, labor, industry, consumer groups, and federal agencies have worked together effectively in ways that provide useful models for other health problems. Since hypertension is especially prevalent in the black community, a special effort in minority communities has been mounted in recent years. In view of the heavy burden of illness altogether in these communities, the lessons learned from the hypertension program may well be useful in other contexts. Recent surveys give encouraging indications with respect to effectiveness of this program. For example, a 1977 study of more than 100,000 residents of Chicago showed that 9 out of 10 people with elevated blood pressure were aware of it and about 60 per cent of hypertensives were being effectively treated.²⁰

The Stanford Heart Disease Prevention Program, a multifaceted research effort, has been shown that decreasing risk factors associated with cardiovascular disease is possible through health education.²¹ The main risk factors addressed in this two-year community education field study were cigarette smoking, high plasma-cholesterol concentrations, and high blood pressure. The experiment involved two experimental Northern California communities (and one control community), and used either mass media alone or mass media plus face-to-face counseling of high risk individuals. Key aspects were:

- the mass media materials were devised to teach specific behavioral skills, e.g., preparation of a palatable low-fat diet—as well as offering health-relevant information and af-

fecting motivation to change behavior in health-promoting directions;

- both the mass media approaches and the face-to-face instruction used well-established behavioral science principles to achieve changes in behavior;
- the design of the campaign was based upon analysis of the knowledge deficits and the media-consumption patterns of the intended audience.

Among high-risk participants receiving the combination of annual survey mass media exposure, and intensive instruction, there was a 30 per cent reduction of overall cardiovascular disease risk—almost all of which was achieved in the first year of the program, and sustained through the second year. High-risk individuals who received only the annual survey and mass media education reduced their risk by about 10 per cent the first year and 25 per cent after two years. In contrast, high-risk participants in the control community exposed to the survey alone did not appreciably change their risk of heart disease. Indeed, the risk to all participants in the control community increased about seven per cent during the study period.

A much larger effort to establish the effectiveness of cardiovascular risk-factor reduction in decreasing the incidence of heart attack and stroke has been going on for six years, involving 180,000 persons, virtually the entire population of North Karelia, Finland.²² At the outset, this county had proportionately more heart disease deaths than any other part of Finland, with most of the regional difference related to a higher incidence of the common cardiovascular risk factors—cigarette smoking, elevated blood pressure, and elevated plasma cholesterol.

The state-financed prevention program was planned in cooperation with the World Health Organization. Major components of the program were: 1) health education through a variety of community resources, including local newspapers and radio; 2) hypertension screening with intensive group health education directed at high-risk individuals; and 3) early diagnosis, treatment, and rehabilitation, involving many existing health and social services of the county.

In the first four and one-half years of the program, the percentage of middle-aged men (25-59 years) who smoke was reduced through a combination of education and legal measures (forbidding smoking in public buildings and on public transport). During the same period, dietary fat was reduced, the program having gained the cooperation of the local dairy and food industry in fat reduction efforts. Nearly every adult in the county receives regular blood pressure measurement, and the percentage of men and women on antihypertensive medication has increased. A reduction in blood pressure has occurred among the 17,000 registered hypertensive individuals.

The result of these combined efforts is that annual incidence rates of acute myocardial infarction, which had been increasing in Finland for many years, have reversed their historic trend. There also has been a change from more severe heart attacks toward less severe attacks. Beginning in the third year of the program, the annual incidence rate of strokes has fallen. North Karelia has also experienced a re-

duction in total male mortality that is more favorable than that experienced by other East Finnish counties. Six years after the initiation of a health promotion program, the annual mortality rate among middle aged males had dropped 15 per cent, heart attacks had fallen by 15 per cent, and strokes had decreased 30 per cent.

The experiences in California and Finland indicate that community-based prevention programs combining modern techniques of public health, behavioral science, and biomedical research can effectively reduce the risk of cardiovascular disease and some forms of cancer as well. It is reasonable to suppose that such work will have a high priority in the future.

Cancer

Cancer is no longer viewed as an inevitable concomitant of aging processes. Environmental factors acting upon genetic predispositions are now viewed as important in the origin of cancer's burden. To the extent that causal factors can be identified, they can in principle either be eliminated from the environment or counteracted so as to prevent cancer.^{23, 24}

The growing recognition of environmental influences is based in part on large geographic variations in the incidence of specific cancers, linked with evidence that migrant populations tend to shift to the incidence patterns typical of their new region. Some environmental substances become carcinogenic only after metabolism within the body. Individual differences in metabolism of these carcinogens may be influenced both by genetic factors and by interaction with other environmental influences. The genetic material DNA probably constitutes the critical molecular target for carcinogens. Inadequate repair of damage to DNA by environmental agents may well be a fundamental mechanism in carcinogenesis. Most, but not all, carcinogenic substances have been found to be mutagenic. Compounds have been discovered that by themselves are neither mutagenic nor carcinogenic but which act as cancer-promoting agents by enhancing the action of carcinogens. The mechanism of this action is beginning to be investigated.

Quantitative data on dose-response relations are available for some agents affecting the incidence of cancer in man. These include ionizing radiation and cigarettes. In both cases, the data are consistent with non-threshold functions—i.e., the evidence does not suggest a threshold below which carcinogenic risk disappears. In experimental animals, most studies involve large doses of carcinogens, and are therefore ambiguous with respect to the threshold question. The few experiments that have tested small as well as large doses have given no indication of thresholds. Further, two carcinogenic agents acting together can exert synergistic effects. Overall, this evidence does not provide a basis for assuming that there is a completely safe level of a carcinogen. Since real-life circumstances often make total avoidance of a carcinogen impossible, the establishment of socially acceptable exposure levels will require dependable, quantitative risk estimates based on more adequate data than most of what is

now available. Such data must be linked to deeper knowledge of individual behavior and social context in order to achieve prevention of cancer related to environmental and behavioral risks.

Epidemiology has a long history of accomplishment in the understanding and practical control of infectious diseases through public health measures. Now it is being increasingly applied to contemporary epidemics of cancer, cardiovascular disease, and mental illness. Its application to cancer is difficult because the physical, chemical, biological, and social environments are so complex, so many putative carcinogens are present, the conditions of exposure so variable, and the durations of latent periods after exposure so long. But illuminating cases have occurred in which people have unfortunately been exposed at unusually high dose levels, leading to the identification of several dozen substances carcinogenic for humans. Changing patterns of environmental agents and changing cancer incidence require large-scale epidemiological research, with special attention to those cancers occurring most frequently and with large geographic variations.

The human species is being exposed to an evolutionary novelty in the new chemical environment. The central problem here is the exposure to a much wider variety of chemical compounds than ever before—in food, medicine, cosmetics, industrial work-places, and the environment generally. Since World War II, this exposure has increased dramatically—unprecedented in the entire history of the human species. How well are we adapted to these molecules? Are we ingesting, breathing, touching, handling substances that increase our risk for serious diseases? If so, how great is the risk for different classes of substances? For a given substance, evidently the risk is greater for some people than for others. Can vulnerable people be identified? Are there monitoring systems that can provide early warning of serious risks? Whose responsibility is it to develop and to apply such systems? These are difficult questions that require thoughtful attention from the health sciences community and from the public. If it should turn out in the decades ahead that many of these molecules have long-term pathological effects, the consequences could be formidable, not only for the health system, but for the economic system as well.²⁵

The past quarter century has seen an unprecedented flourishing of the life sciences.²⁶ It is appropriate now to examine systematically in a forward-looking way the implications of these extraordinary advances in the life sciences for disease prevention in general and cancer prevention in particular.²⁷ The effort to find effective preventive interventions must be a continuing one—far into the future. There is probably a good deal of cancer that can be prevented by judicious application of existing knowledge. By identifying risk factors and learning how to modify exposure to them, much can be accomplished—as the historical record abundantly demonstrates. As more and more knowledge accumulates of mechanisms underlying these risk factors, and their specific modes of action, systematic efforts can be made to utilize this information for preventive purposes. In principle, such insights should greatly enhance our capability for cancer prevention.

Genetics and Susceptibility to Disease

Ecogenetics is a term recently coined to designate the study of the influence of genetic factors on the response to environmental agents. Principles derived from drug research—i.e., pharmacogenetics—probably apply to potentially carcinogenic chemicals. Persons with certain genetically determined metabolic variations—such as those who inactivate an environmental agent slowly or those who transform it into a more potent carcinogen—are most likely to develop cancer on exposure to the risky substance. Other people, free from these metabolic peculiarities, might require a much larger exposure to the same substance before developing cancer. This approach is being applied to the important problem of differential susceptibility to the aromatic hydrocarbons that are one of the toxic components in cigarette smoke. This research is still at an early stage. Similar considerations apply to gene-environment interaction in arteriosclerosis. In this instance, genetically determined individual differences in response to components of dietary intake may have an important bearing on the extent and severity of the disease.

Over many years, many laboratory experiments in a variety of animal species have shown a relationship between dietary saturated fats, plasma cholesterol levels, and arteriosclerosis. These relationships have been abundantly confirmed in man. Thus, the nature and extent of dietary fat intake has a bearing on arteriosclerosis (and quite possibly on two common cancers (colon and breast) as well). But not everyone who consistently eats a diet high in saturated fats develops any of these diseases. Although there is an elevated risk for those who eat such diets, some are more vulnerable than others.

An important discovery of recent years is that high concentrations of fat in human blood can be strongly influenced by certain genetic characteristics. Indeed, three distinct single-gene disorders can predispose to hyperlipidemia. Our growing ability for early detection of those persons who are at high risk can facilitate sharply focused preventive efforts.

Behavior Changes and Disease Prevention

Both in the U.S and abroad, we are looking, however hesitantly, toward disease prevention aimed at environmental and life-style factors that contribute to illness and death. Some of these are addressed to individual behavioral changes, while others are matters of social organization that involve the urban environment, the workplace, education, transportation, and other sectors—certainly including medical care but going beyond. We face large issues of public education and the desirability of giving people more choice about how they will use their lives. This is a formidable long-term task, which requires more collaboration than we are accustomed to in the health field—not only collaboration across scientific and professional disciplines, but across governmental and educational sectors.

Recurrent questions persist in such matters. Can behavior really be changed (e.g., smoking)? Some typical problems involve the ubiquitous human capacity for wishful thinking.

1. Only some people who smoke will be adversely affected. "Somebody else, not me."

2. Adverse effects, if any, are a long way off. "Why worry about that now?"

Yet more than 30 million adult heavy smokers have stopped smoking in an enduring way since the Surgeon General's report in 1964. We know little about how they managed to do so, but we do know it was related to concerns about health. Most people do not want to commit suicide, rapidly or slowly. Then who is keeping cigarette smoking at a high level? Adolescents, especially early adolescents, and particularly females.

Adolescence and Disease Prevention

The onset of adolescence is a critical period of biological and psychological change for the individual. Puberty is one of the most far-reaching physiological upheavals in the life-span. For many, it involves a drastic change in social environment as well: the transition from elementary to secondary school. These years are highly formative for health-relevant behavior patterns such as smoking of cigarettes, the use of alcohol or other drugs, the driving of automobiles and motorcycles, habits of food intake and exercise, and patterns of human relationship including high-risk pregnancy and sexually transmitted disease.²⁸

Recent advances in biological, behavioral, clinical and epidemiological research have begun to clarify this great transition from childhood to adulthood. Radioimmunoassay makes possible precise and reliable measurement of the pituitary and gonadal endocrine changes of puberty. The hypothalamic hormones are rapidly becoming available for experimental and clinical use. Individual differences in endocrine function can now be systematically studied in relation to growth patterns, behavioral changes, and clinical disorders. Behavioral and social research on this phase are being intensified. The conjunction of urgent social problems and new scientific opportunities makes it likely that deeper understanding of this major transition will be achieved in the next decade. If utilized wisely in health, education (in the broadest sense), and social services, this information can greatly enhance our ability to prevent some of the disorders that arise in adolescence. This, in turn, would decrease the adverse impact of adolescent disorders on health in adult life.

Morbidity in adolescence has traditionally been underestimated; in any event, it has been on the rise in recent years. Some of the morbidity has both immediate and long-term effects—for example, sexually transmitted diseases; premature, high-risk pregnancy in early adolescence; vehicle accidents. Other problems are the long-term risks for cancer, cardiovascular disease, and mental illness posed by heavy cigarette smoking, maladaptive dietary patterns, heavy alcohol use, and maladaptive human relationships.

Adolescents are rapidly learning how to become adults. They can benefit from anticipatory guidance in respect to vital matters of human biology, health, disease, and behavioral adaptation. Before health-damaging patterns are firmly established, there is a crucial opportunity for preventive intervention.

But how is it possible to reach adolescents in credible ways that are likely to diminish health-damaging behavior? Is it feasible to reach out to them where they spend their time, and capture their interest and imagination in ways that fit their own orientations? There are several places where adolescents may be reached in large numbers, including the health services, the schools, the mass media, and their own homes.

Adolescents have not fared well in health services—tending to fall between pediatrics and medicine, between child and adult psychiatry, even missing primary care services—partly on the wishful assumption that their troubles will automatically pass, and, paradoxically, partly on the pessimistic assumption that they are too difficult to work with. It is encouraging to note that multi-service centers for adolescents have been emerging in recent years, and some of the leading academic health centers have organized adolescent units.

A large percentage of adolescents—and especially of early adolescents—are in school. Efforts are now being made to strengthen and change traditional school health efforts in ways likely to prevent disease and protect health throughout the life span.

One approach to adolescent problems, a peer counseling program developed by Beatrix A. Hamburg for junior and senior high schools, rests upon an analysis of developmental tasks and coping strategies.²⁹ Utilizing the credibility of peers in adolescence, the program trains students to help other students. It does so largely by clarifying the tasks and strategies characteristic of this phase of the life cycle in a particular setting, by providing information on the processes of interpersonal relationship, and by providing continuing supervision to the student counselors. Findings suggest that the program is useful for both counselees and counselors. This innovation succeeded in developing a self-sustaining peer counseling program that functions effectively within a school system with a minimum necessity for involvement of mental health professionals. A detailed curriculum for the training of peer counselors has evolved, and a training program for teachers and professional counselors has been developed to aid them in selecting, training, and supervising students as peer counselors. This approach has recently been extended to field experiments designed to test the efficacy of peer counseling in preventing the onset of cigarette smoking.³⁰ Sixteen-year-olds are trained to counsel 12-year-olds in such matters as resisting peer pressure toward smoking. So far, the results are encouraging. Other innovations in school and family preventive interventions are also emerging.³¹

An area of special and novel significance is the enormous range and impact of the modern mass media. Television, radio, and magazines are especially salient to adolescents in contemporary America. Can health-damaging content of media be diminished? Present entertainment and advertising put considerable emphasis on alcohol, tobacco, risky driving, and violence. There may well be lessons to be learned from the scientific and public efforts to analyze and lessen violence on television. A body of systematic research has rapidly evolved in recent years. The findings of this re-

search have been utilized by public organizations such as the Parent Teachers Association, the American Medical Association, Action for Children's Television, and many church groups. Can health-promoting material be used in interesting and credible ways? Can public television and public radio provide leadership in such efforts? These matters deserve serious and sustained consideration by the health community, since, for better or for worse, the media have become a highly significant part of modern education.

In any event, health is related to other aspects of adolescence which have much long-term significance for the quality of individual lives and of modern society altogether. These include quests that shape the course of life: for self-respect; for skills, preferably marketable, but in any event socially useful; for dependable human relationship and a sense of belonging in a valued group; for a sense of future opportunity; and for respect in a time of marginal status—i.e., between childhood and adulthood. To help adolescents move in these directions is to promote health. We must learn more about ways of facilitating such development in the new conditions of our society.

Broadening the Spectrum of Health Research

As we learn more about the burden of illness in this country, the importance of behavioral factors for health becomes increasingly clear. But the point is more general. As the burden of illness changes, the sciences needed to lessen the burden also change. This point was earlier made in relation to epidemiology. Similarly, as new scientific opportunities arise, their relevance to disease must be sought by those responsible for the health of the nation. New gardens of science must be cultivated, old biases discarded, conventional wisdoms set aside in the face of new observations, fresh ideas, and neglected social responsibilities. It was not so long ago that the emerging discipline of biochemistry was viewed with suspicion by chemists as weak chemistry and by biologists as weak biology. Today this hybrid discipline has become the central discipline of biomedical research. And, it was not so long ago that most leaders in medicine were very doubtful if genetics would have any practical significance for health in the twentieth century. Today genetics is one of the most dynamic areas of medicine. These lessons should be borne in mind in the years ahead, as the health sciences adapt to new problems and new opportunities.

Health and Behavior in Evolutionary Perspective

The time scale of evolution highlights a dilemma in the current predicaments of human health and disease. There have been mammals on earth for more than 70 million years. Primates appeared early among the mammals. A manlike form has been present for several million years. Yet agriculture has been effectively present on a worldwide basis for only a few thousand years. The Industrial Revolution occurred about 200 years ago, and is only beginning now in some parts of the world. So, on an evolutionary time-scale, the world we live in is mainly one that we have made for ourselves very recently indeed.

We are suddenly in a vast world of enormous complexities, rapid technological change, social upheavals, vast

heterogeneity, cross-cutting interests, diverse pressures, world interdependence, and unimaginable weapons. Our power, for better or for worse, suddenly dwarfs all history. In contemporary societies, conflict between groups is common, often destructive, and highly varied in content. Yet there are widely shared properties in the form of such antagonisms that may help to clarify serious human conflict. Human societies have a pervasive tendency to make distinctions between putatively good and bad people, between heroes and villains, between groups and out groups. Justification for harming outgroup members rests on sharp between "we" and "they". A great variety of political, socioeconomic, and pseudoscientific ideologies have been utilized to justify these hostile positions. This group-centered view of life has been studied by social scientists and is usually referred to as ethnocentrism.³²

Studies of ethnocentrism have, in fact, specified groups not only by ethnicity but by religion, race, language, region, tribe, nation, and political entities. The same principles seem to apply across these various groups. A crucial question is whether groups can achieve internal cohesion, self-respect, and adaptive effectiveness without promoting hatred and violence. A deeper understanding of factors that exacerbate and prevent "groupocentrism" could have great practical value in resolving intergroup conflicts in the future. Such conflicts have, I need hardly remind you, enormous significance for health. The prevention of nuclear war may well be the most important public health problem in all of history.

The health of our population is related to the enormous transition that our species has brought about since the industrial revolution and especially in the twentieth century.³³ Rapid population growth in most of the world, urbanization with its difficult ramifications, environmental damage and resource depletion, the risks of weapons technology, and new patterns of disease—are all largely products of changes that have occurred only in the most recent phase of human evolution. We have changed our diet, (e.g., high fat); our activity patterns (e.g., sedentary life); our technology (e.g., transportation); the substances of daily use and exposure (e.g., in the work place); our patterns of reproductive activity; of tension relief (e.g., smoking and alcohol); and of human relationships. Many of these changes are truly epochal in character, laden with new benefits and new risks, and most of the long-term consequences are poorly understood. Natural selection over millions of years shaped our ancestors in ways that suited earlier environments. We do not know how well we are now suited biologically and behaviorally to the world our species has so rapidly made.

This situation provides a powerful stimulus for the life sciences, broadly defined. A wide spectrum of research is needed to meet long-range health problems. We are now entering an era of testing the extent to which the methods of the sciences can be brought to bear on the entire range of factors that determine the health of the public—not only through medical care but also in the way we manage our personal behavior patterns and our changing environment.

Surely, the present conditions of human life represent one of the most drastic transformations any species has ever brought about in so short a time. Its consequences—planned

and unplanned, witting and unwitting, beneficial and adverse—deserve a high priority in the science of the future. This is not merely a medical problem or even a health problem. In this framework, the scholars of many disciplines can be brought together in ways I believe they will find stimulating and socially helpful. The enormous transformation of this poignant moment of evolutionary time increases the urgency of our need to know—above all about ourselves. Not just about our health, but our environment, our behavior, our relations with each other as individuals, as institutions, and as nations. Here is a challenge we cannot afford to overlook. If we have the vision, we can deal with problems of utmost significance, not only for our health, but for our future as a species.

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